

CALIFORNIA DIVISION OF MINES AND GEOLOGY  
FAULT EVALUATION REPORT FER-180  
Homestead Valley fault, Johnson Valley fault,  
and associated faults,  
San Bernardino County, California  
by  
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INTRODUCTION

As required by law, CDMG evaluates faults for potential surface rupture hazard (Hart, 1985, p. 2, 5, 6). The Homestead Valley and Johnson Valley faults, and three unnamed faults associated with them, have been examined as part of this Fault Evaluation Program. Portions of these faults have been mapped by previous workers (Dibblee, 1964, 1967a, 1967c; Dokka, 1983; Gardner, 1940; Hill and others, 1980; Morton and others, 1980; Riley and Moyle, 1960), and historic fault rupture is documented for the southern segments of the Homestead Valley and Johnson Valley faults (Hill and others, 1980). Because of these and other available reports, and air photo evidence and field observations that are described below, several of these fault traces are considered to be "sufficiently active and well-defined" faults and are recommended for zoning under the Alquist-Priolo Special Studies Zones Act.

SUMMARY OF AVAILABLE DATA

The Homestead Valley, Johnson Valley, and three associated faults are part of a series of subparallel, northwest-trending, right-lateral strike-slip faults in the western Mojave Desert. Figure 1 (from Jennings, 1975) shows these five faults in relation to other faults in the region, several of which are examined in other FER's. Figure 2 shows the U.S.G.S. topographic quadrangles traversed by the faults examined herein.

Homestead Valley fault

Riley and Moyle (1960) produced a reconnaissance geologic map as part of a regional groundwater study (Bader and Moyle, 1960). They show two discontinuous segments of the (unnamed) Homestead Valley fault in the Emerson Lake 15' quadrangle -- the well-defined segment in bedrock east of Means Lake, and the generally-concealed segment in Pipes Wash along the eastern flank of Hill 3467. Most of their mapping is similar to that of Dibblee (1967a) (below). However, they do show a southeastern extension of the Pipes Wash segment (see Figures 3 and 4D), which is not verified by Dibblee. The extension is shown to be concealed by Holocene alluvium in Pipes Wash, and to offset Pleistocene alluvium near Landers.

The Homestead Valley fault was mapped in its entirety by Dibblee (1964, 1967a, 1967c), who shows the unnamed, southeast-trending splay of the Emerson fault to have an overall length of 27 km (17 miles). [The junction of the northwest end of the Homestead Valley fault and the Emerson fault is not examined in this report; see FER-183.] The Homestead Valley fault is shown by Dibblee (1967a, 1967c) to separate Mesozoic bedrock and younger alluvium (very

late Pleistocene and Holocene, undifferentiated), and locally to offset and be concealed by younger alluvium and windblown sand (see Figure 3). Sense of displacement is shown to be right-lateral strike-slip. Southeast of Means Lake, Dibblee (1967c) interprets the fault as having two subparallel branches that encompass a large, northwest-trending bedrock ridge (see Figure 3).

A series of moderate-magnitude earthquakes that occurred on 15 March 1979 resulted in surface rupture in younger alluvium along the southern segment of the Homestead Valley fault in the Landers 7.5' quadrangle (Hawkins and McNey, 1979; Hill and others, 1980; Hutton and others, 1980; McJunkin, 1980; Stierman and others, 1980). Of these several reports, that of Hill and others provides the best report of geology and surface rupture. Hawkins and McNey provide a reconnaissance report, while the remaining articles describe other aspects of the earthquakes.

In their report, Hawkins and McNey (1979) use the term "Pipes Wash fault" in referring to Dibblee's unnamed fault. However, Hill and others (1980, p. 61) prefer the name "Homestead Valley fault", in order to avoid confusion with the Pipes Canyon fault southwest of Homestead Valley. According to Hill and others (1980), surface rupture associated with the 15 March 1979 earthquakes extended for 3.25 km (2 miles) across younger alluvium and localized bedrock in the northern half of Homestead Valley (see Figure 4D). [The fault traces shown in Figure 4D are from 1:24,000-scale, unpublished mapping by Hill and others.] Relative movement along the Homestead Valley fault was right-oblique slip, west side up, with a dominant right-lateral component. Width of the fault zone increased from 1 meter at the north end to 100 meters (328 feet) at the south end. The south end of the fault butts into the unnamed mountain [Hill 3467] southwest of Spy Mountain, and splays into several strands (see Figure 4D). Surface rupture consisted generally of left-stepping, en echelon cracks and zones of cracks, bands of parallel cracks, and a few "mole tracks". The cracks had horizontal displacements of up to 5 cm (2.0 inches). The cumulative horizontal displacement was at least 10 cm (p. 67). Some cracks had vertical displacements of up to 4 cm (1.6 inches), forming small horsts and grabens (Hill and others, 1980, p. 63-64). ✓

Additional ground rupture was located in Pipes Wash (see Figure 4D). Large-scale slumping and cracking of colluvium for several hundred meters along the linear northeast bank of Pipes Wash has led Hawkins and McNey (1979, p. 223) to infer the presence of a previously unmapped fault at that location. Hill and others (1980, p. 65) acknowledge the possibility of a fault, but feel that the long crack is "an incipient slump crack".

#### Johnson Valley fault

The best-available geologic maps of the Johnson Valley fault are those of Dibblee (1964, 1967a, 1967c), who named the fault (see Figure 3). Reconnaissance mapping by Riley and Moyle (1960) shows only the fault segment within the Emerson Lake 15' quadrangle. Smaller-scale mapping by Vaughan (1922) and Gardner (1940) shows only the central and northern fault segments, respectively. [Their traces are not shown on Figure 3.] Fault traces shown by French (1977) in his ground-water study are generalized from Dibblee's mapping.

Dibblee (1964, 1967a, 1967c) shows the northwest-trending Johnson Valley fault to have a total length of approximately 39 km (24 miles). [A southern extension of the Johnson Valley fault, shown by Riley and Moyle (1960) in the Joshua Tree 15' quadrangle, is examined in FER-181 by W.A. Bryant.] Dibblee shows the fault to have right-oblique displacement (northeast side down) south of Melville Lake, with a large horst formed between the main trace and a more southerly splay (Dibblee, 1967b). At other locations the fault has vertical displacement or the sense of offset is not indicated (see Figure 3). In cross-section the fault is shown to be vertical or nearly vertical, with a maximum vertical displacement of approximately 1500 feet (450 meters). Possible right-lateral displacement of up to one mile (1.6 km) is indicated by offset bedrock units south of Melville Lake (see Figure 3). Locally, he shows the fault as concealed by younger alluvium (Holocene or undifferentiated Holocene and Pleistocene), or offsetting and being concealed by older alluvium (Pleistocene), or as separating younger and older alluvium or older alluvium and Mesozoic bedrock. Immediately southwest of Melville Lake, in sec. 17, Dibblee shows faulted younger alluvium, but this may be a drafting error.

Riley and Moyle (1960) show the fault in a similar location as Dibblee (1967a), but they extend the fault southward into the Joshua Tree 15' quadrangle (see Bryant, 1986). They interpret the fault as offsetting all older alluvium along its trace, and as being concealed locally by younger (Holocene) alluvium. Due to the similarity of their map to Dibblee's, only a fault segment west of Landers that is not verified by Dibblee (1967a) is shown on Figure 3.

Morton and others (1980) used black-and-white, low-sun-angle air photos to produce their photoreconnaissance map of fault-related features along the northern half of the Johnson Valley fault (see Figures 4A and 4B). Their annotated strip map, at scales of 1:24,000 and 1:62,500, shows alignments of scarps and linear canyons in bedrock along the general trend of the fault as mapped by Dibblee (see above). However, they did not field-check the geomorphic features, nor do they discuss recency of faulting. Nonetheless, their identification of scarps and other fault-related features in younger alluvium clearly suggests very late Pleistocene and Holocene activity in several places. Most of the fault-related features shown by Morton and others were verified by photo-inspection and field-inspection during this study (see Figures 4A and 4B, and discussion below).

Bull (1978) includes a reconnaissance appraisal of Quaternary tectonic activity along the Johnson Valley fault. He uses five differential equations, which interrelate uplift, erosion, and deposition along streams that cross mountain fronts, to divide major mountain ranges along the fault into one of three classes of terrain. According to Bull (1978, p. 33), "Class 1 ['active'] fronts occur in highly active tectonic settings that are generally characterized by active folding and/or faulting during the Holocene as well as the Pleistocene. Class 2 ['slightly active'] faulted mountain fronts generally have ruptured Pleistocene, but not Holocene, geomorphic surfaces. \*\*\* Class 3 ['inactive'] mountain fronts, by definition, have been tectonically inactive during the Quaternary." Of the eight mountain fronts along the Johnson Valley fault that were analyzed by Bull (p. 183), six are classified as "active", and two are classified as inactive" (see Figure 3). He considers the Johnson Valley fault to be active within the Rodman Mountains and Old Woman Springs 15' quadrangles, and slightly active or inactive in the Emerson Lake 15' quadrangle (Bull, 1978, Fig. 18). He gives no additional documentation of Holocene activity along the Johnson Valley fault.

Hill and others (1980) describe fault rupture that occurred along the southernmost segments of the Homestead Valley and Johnson Valley faults on 15 March 1979 during a series of earthquakes of magnitude 3.0 to 5.2. [The surface faulting shown on Figure 4 is based on unpublished, 1:24,000-scale mapping by Hill and others.] The zone of surface rupture along the Johnson Valley fault was 1.45 km (0.9 miles) in length, entirely within alluvium of undifferentiated Pleistocene and Holocene age. The rupture consisted of left-stepping, en echelon cracks or bands of cracks, with maximum horizontal displacements of 1.0 cm (0.4 inches) or less. Vertical displacement was observed at only two locations, with a maximum offset of 1.0 cm (0.4 inches), east side up. Hill and others (1980, p. 66) suggest that the vertical component along this fault segment may be due to differential compaction of the alluvium, and that right-lateral displacement along the fault is probably predominant.

#### Faults "A", "B", and "C"

These unnamed, northwest-trending faults are shown by Dibblee (1967c; see Figure 3). Fault "A" lies between and is subparallel to the Johnson Valley fault and Lenwood fault. [The Lenwood fault is examined in FER-177.] Dibblee shows Fault "A" to have a length of 8 km (5 miles). It displaces both older alluvium (Pleistocene) and younger alluvium (undifferentiated Holocene and very late Pleistocene). He does not show the fault in cross section, and no sense of displacement is indicated. Bull (1978, Figure 18) classifies Fault "A" as "inactive", based on the adjacent Class 3 mountain front (see Figure 3). Morton and others (1980) noted subdued scarps and prominent changes in vegetation along the fault (see Figure 4B).

Fault "B" lies at the base of the western side of a mountain immediately east of Melville Lake (see Figures 3 and 4B). Dibblee shows this northwest-trending fault to have a length of 5.1 km (3.2 miles) with vertical displacement (east side up). The fault is entirely concealed beneath dune sand of undifferentiated Holocene and very late Pleistocene age. It is not shown by either Bull (1978) or Morton and others (1980).

Fault "C" is a short (2.6 km; 1.6 mile), northwest-trending fault approximately 1 km east of fault "B" (see Figures 3 and 4B). Most of the fault lies within bedrock; the southeast end of the fault is concealed by young alluvium. Neither Bull (1978) nor Morton and others (1980) show this fault.

#### AIR PHOTO INTERPRETATION AND FIELD OBSERVATIONS

My air photo interpretation and field observations are shown on Figures 4A - 4D. Two sets of black-and-white air photos were available to me: U.S.B.L.M., 1977, series CA 93-77; and U.S.B.L.M., 1978, series CAHD-77. The low-sun-angle air photos used by Morton and others were not available. Field inspections of the Homestead Valley and Johnson Valley faults were made by me on June 2-6, 1986. Faults "A", "B", and "C" were not field-checked, due to time constraints. Glenn Borchardt, CDMG, assisted in field work and soils descriptions. Earl Hart, CDMG, assisted in air photo interpretations.

### Homestead Valley fault

The Homestead Valley fault is geomorphically well defined in bedrock as a series of scarps, offset ridges, linear drainages, deflected drainages, and shutter ridges northeast of Homestead Valley (see Figures 4B, 4C, and 4D). Dune sand and alluvium of undifferentiated Holocene and very late Pleistocene age (Dibblee, 1967a, 1967c) conceal the fault along much of its length; there is only slight air photo evidence of faulting in the young alluvium south of Linn Road (see Figure 4D). Just north of Mikiska Boulevard (Figure 4D), the southeast end of the mappable trace merges with the northwest end of the surface rupture that resulted from the 15 March 1979 earthquakes in Homestead Valley (Hill and others, unpublished). Quaternary displacement along the main trace of the Homestead Valley fault is probably at least 300 meters (1000 feet). This estimate is based upon an offset ridge near the northwest end of the fault (Figure 4B) and a large deflected drainage east of Means Lake (Figure 4C). The northwest end of the Homestead Valley fault, north of the Melville Lake quadrangle, was not evaluated in this report; it has been examined as part of the Emerson fault in FER-183.

The inferred fault of Hawkins and McNey (1979) shown on Figure 4D has been extended in both directions, based on the linearity of the northeast bank of Pipes Wash. Although the wash has a very steep channel wall, no evidence of faulting in the Pleistocene alluvium that forms the wall was seen in a road-cut near Location PW-3. In addition, there are other locations along Pipes Wash southwest of (upstream from) Landers where one bank is very linear (see Riley and Moyle, 1960; Dibblee, 1967a, 1967b), indicating that faulting probably has no influence on stream bank linearity.

### Johnson Valley fault

The Johnson Valley fault is moderately well-defined in bedrock and poorly to moderately well-defined in alluvium, as a zone of discontinuous scarps, breaks-in-slope, linear drainages, deflected drainages, and an offset fan (see Figures 4A, 4B, and 4D). Most, but not all, of the features noted by Morton and others (1980) were verified during this study. Dune sand and young alluvium (very late Pleistocene and Holocene, undifferentiated; Dibblee, 1967a, 1967c) locally conceal the fault. Surface rupture associated with the 15 March 1979 earthquakes in Homestead Valley coincided with mappable fault features in younger and older (Pleistocene) alluvium (see Figure 4D). Young alluvium (Holocene; Dibblee 1964) completely conceals the active trace locally in the Fry Mountains 7.5' quadrangle, although the north end of the fault can be followed as a series of breaks-in-slope and linear drainages in bedrock (see Figure 4A).

### Fault "A"

Fault "A" can be followed on the available air photos as a northwest-trending alignment of scarps and tonals in younger alluvium and older alluvium (see Figures 4A and 4B). Most, but not all, of the features noted by Morton and others (1980) were verified during this study. The northeast-facing scarps east of Pony Road appear locally to truncate northeast-drifting dune sands, but elsewhere are partially covered by them, indicating right-oblique displacement (southwest-side up) has occurred along the fault since the very late Pleistocene.

### Fault "B"

No air photo evidence was seen of recent faulting along the trend of Fault "B" as shown by Dibblee (1967c). The trace of the inferred fault is completely covered by dune sand.

### Fault "C"

As shown by Dibblee (1967c), Fault "C" lies almost entirely within bedrock, and the fault is visible on air photos as an eroded fault zone. Young alluvium conceals the southeast end of the fault. However, the fault may continue further southeastward than shown by Dibblee, as an alignment of back-facing bedrock scarps and a deflected drainage and saddle in bedrock (see Figure 4B).

### SEISMICITY

Figure 5 shows the regional seismicity ("A" and "B" quality data) for the Homestead Valley-Johnson Valley area for the period 1969-1984. According to Hutton and others (1980, p. 110 and Figure 6), only one event, of magnitude 2.5 to 3.0, occurred in Homestead Valley during the period 1 January 1970 to 14 March 1979, while more than 3000 earthquakes occurred there between 15 March and 30 June 1979.

### CONCLUSIONS

1. The Homestead Valley fault is an active, southeast-trending, right-lateral strike-slip fault, that extends from near the Emerson fault southeastward to Homestead Valley (Figure 3). The fault is generally well-defined in bedrock, but is concealed locally by younger alluvium and dune sand of undifferentiated Holocene and very late Pleistocene age (Figures 4B - 4D, and Dibblee, 1967a, 1967c). Surface rupture in young alluvium occurred along the fault in Homestead Valley on 15 March 1979. Length of surface rupture was 3.25 km with cumulative right-lateral displacement of at least 10 cm (Hill and others, 1980). Cumulative lateral displacement along the Homestead Valley fault is a minimum of 300 meters (1000 feet), based on displacements of an offset ridge and a deflected drainage in bedrock. An inferred fault in colluvium along the linear, northeast bank of Pipes Wash (Hawkins and McNey, 1979) could not be verified during this study.
2. The Johnson Valley fault is an active right-slip or right-oblique-slip fault that extends southeastward along the western margin of Johnson Valley into Homestead Valley (Figure 3). In the Emerson Lake and Old Woman Springs 15' quadrangles, the fault is generally well-defined in bedrock and is moderately well defined in younger and older alluvium (see Figures 4A - 4D). The fault locally is concealed by younger alluvium and dune sand of Holocene and undifferentiated Holocene and Pleistocene age (Dibblee, 1967a, 1967c). Along the northern segment, in the Rodman Mountains 15' quadrangle, the fault cannot be followed as a surface feature in Holocene alluvium (Dibblee, 1964). The northwest end of the fault follows the bedrock-alluvial contact before dying out. Some of the surface rupture associated with the 15 March 1979 earthquakes in Homestead Valley coincided with mappable geomorphic features along the fault (Hill and others, unpublished; Figure 4D, this report).

3. Fault "A" is a short, northwest-trending, right-oblique-slip fault (southwest side up) located between the Johnson Valley and Lenwood faults (Figure 3). The fault is moderately well-defined on air photos as a linear, northwest-facing scarp and aligned tonal features. Fault "A" offsets older (Pleistocene) alluvium, younger alluvium and, possibly, dune sand (Holocene and very late Pleistocene, undifferentiated).
4. Fault "B" is an inferred fault along the western base of a mountain east of Melville Lake (Figure 3). The fault is shown to be completely concealed by dune sand (Dibblee, 1967c), and could not be verified on air photos as a surface feature.
5. Fault "C" is a northwest-trending fault in bedrock immediately east of Fault "B" (see Figure 3). Fault "C" offsets Mesozoic quartz monzonite, but is shown to be concealed at its south end by younger alluvium (Dibblee, 1967c). No air photo evidence of faulting was seen in the alluvium. The fault may extend further to the southeast than shown by Dibblee, based upon an alignment of geomorphic features in bedrock (see Figure 4C).

#### RECOMMENDATIONS

The Homestead Valley fault, Johnson Valley fault, and Fault "A" generally meet the requirements of "sufficiently active and well-defined" necessary for zoning under the Alquist-Priolo Special Studies Zones Act, and should be zoned as shown in Figures 6A, 6B, 6C, and 6D. References for the Homestead Valley fault should be Hill and others (unpublished) and this report for fault location, and Hill and others (1980) for fault activity. Dibblee (1967a, 1967c) should be cited for confirmation of fault location and recency, although his specific traces were not used. References for the Johnson Valley fault should be Hill and others (unpublished), Dibblee (1964, 1967a, 1967c), and this report for fault location, and Hill and others (1980) for fault recency. References for Fault "A" should be Morton and others (1980) and this report for fault location and recency. Dibblee (1967c) should also be cited for confirmation, although his specific traces were not used.

Faults "B" and "C", and the inferred fault of Hawkins and McNey (1979) do not meet the necessary criteria, and should not be zoned.

Morton and others  
(1980)

*I have reviewed this  
report and generally  
agree with the recommendations.*  
*EW*  
*11/20/86*

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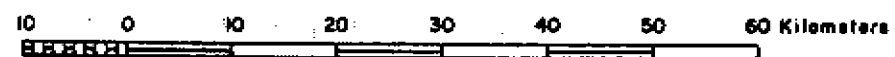
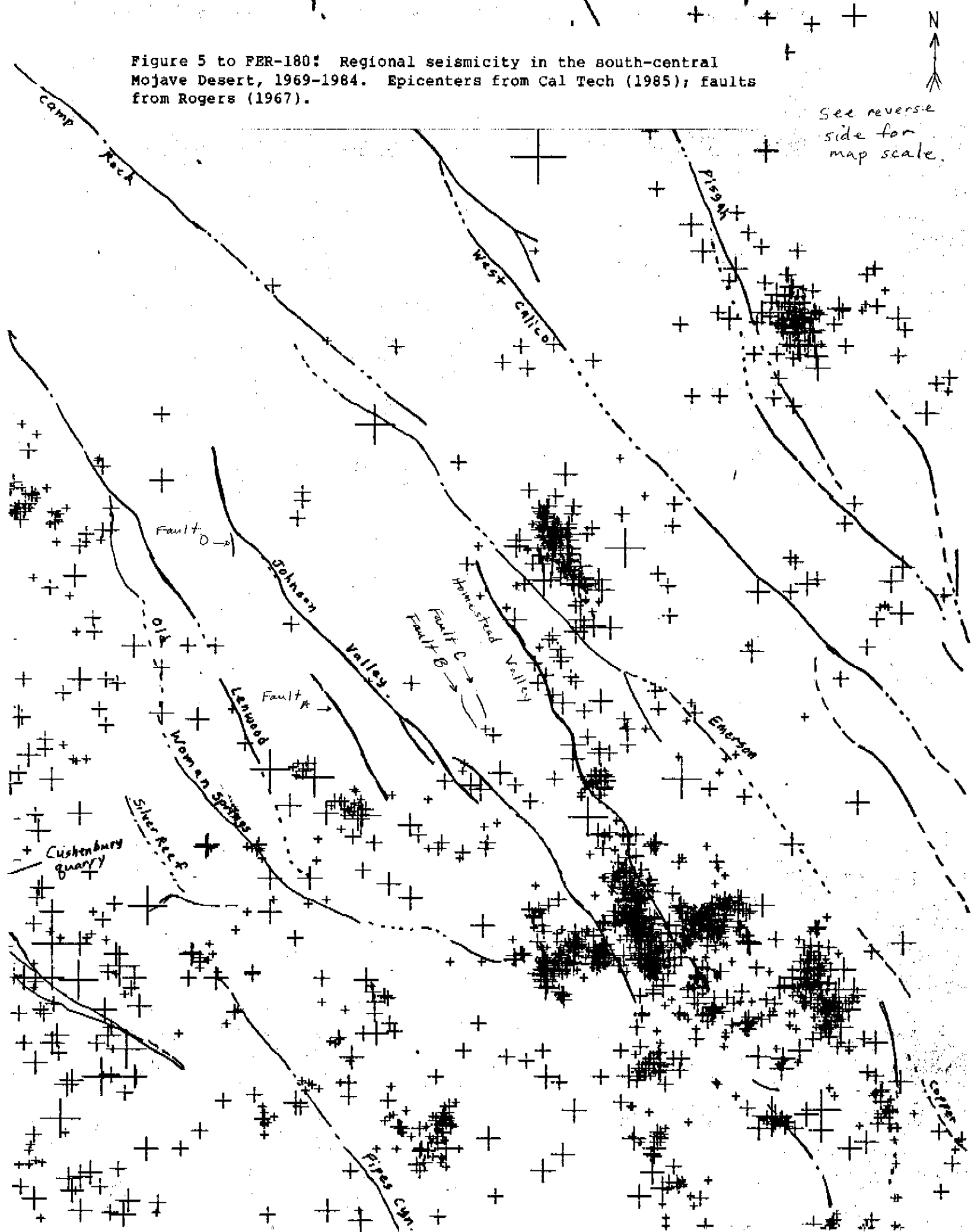




Figure 5 to FER-180: Regional seismicity in the south-central Mojave Desert, 1969-1984. Epicenters from Cal Tech (1985); faults from Rogers (1967).



# EARTHQUAKES M1.0 OR GREATER

CIT 1969-1984 AB QUALITY ONLY

SAN BERNARDINO SHEET

TRANSVERSE MERCATOR PROJECTION

SCALE = 1/250000

MAGNITUDE

